REMARKS

By this amendment, claims 1-4, 6-14, 23-25, 28-30, 33-36, 38-42, 44-51 and 57-63 are pending in the application. Of these, claims 1, 23, 28-30 and 61 are being amended. Claims 26-27 and 37 are being canceled. The amendments to the claims are supported by the original Specification and claims as filed, and add no new subject matter. For example, the amendment to claim 30 is supported at least by the first full paragraph on page 8 of the specification, as well as Figure 1. Reconsideration of the present case in view of the amendments and remarks herein is respectfully requested.

Rejection under 35 U.S.C. 103(a) of Claims 1-4, 6-14, 23-30, 33-42, 44-51 and 57-63

Giapis et al. and Piwonka-Corle

The Examiner rejected claims 1-4, 11-14, 30, 33, 35, 37-39 and 61-63 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 5,002,631 to Giapis et al. in view of U.S. Patent 5,608,526 to Piwonka-Corle (Piwonka-Corle). This rejection is respectfully traversed.

Claim 1 is patentable over Giapis et al. and Piwonka-Corle because the references do not teach or suggest "a signal analyzer to normalize the sample signal relative to the reference signal by mathematically operating on the sample signal to compensate for both (i) a fluctuation in the reflected radiation that originates from the radiation source and (ii) background radiation from the plasma," as in the claim.

The Examiner acknowledges that Giapis et al. does not teach "a signal analyzer adapted to normalize the sample signal relative to the reference signal by mathematically operating ..." The Examiner then relies on Piwonka-Corle to make up for this deficiency.

However, Piwonka-Corle does not make up for this deficiency. In the section to which the Examiner refers, Piwonka-Corle discloses that "processor 100 is programmed to normalize the reflectivity measured by sample beam 9 using the reference beam measurements from detector 273, to compensate for such effects as lamp intensity fluctuations and air currents" (column 15, lines 14-18.) Thus, Piwonka-Corle discloses normalizing a signal to compensate for lamp intensity fluctuations or air currents. Piwonka-Corle does not teach or suggest mathematically operating on a sample signal to compensate for background radiation that is from the plasma, as lamp intensity fluctuations from a lamp used to generate the sample beam and air currents are not background radiation from a plasma. Piwonka-Corle also does not teach or suggest any means by which a sample signal could be normalized to compensate for background radiation from a plasma, and furthermore does not provide any motivation to do so. Accordingly, Piwonka Corle does not teach or suggest the signal analyzer that is capable of operating on a sample signal to compensate for background fluctuations, and claim 1 and the claims depending therefrom are patentable over Giapis et al. and Piwonka-Corle.

Furthermore, the Examiner's assertion "that Piwonka-Corle teaches background radiation compensation during signal processing is supported by Piwonka-Corle's very teaching of polychromatic collection and monochromatic analysis of said specific sample radiation signal" does not follow from the disclosure of Piwonka-Corle. That Piwonka-Corle discloses a detector comprising a photodiode array, "each photodiode in array 136 measur[ing] radiation of a different wavelength" (column 11, lines 60-61) does not mean that Piwonka-Corle is compensating for background radiation from a plasma. Simply detecting multiple wavelengths of radiation, some of which may include background radiation, is not the same as compensating for that radiation during normalization. To compensate for background radiation during normalization is not inherent in the disclosure of Piwonka-Corle because, inter alia, the processor of Piwonka-Corle is not disclosed as being programmed to perform such compensation. In contrast, the analyzer of Claim 1 specifically mathematically operates

on the sample signal to compensate for background radiation from the plasma during normalization of the sample signal. Accordingly, the combination of Giapis et al. with Piwonka-Corle does not teach or suggest the signal analyzer of claim 1, and claim 1 and the claims depending therefrom are patentable over Giapis et al. and Piwonka-Corle.

Claim 30 similarly recites "a signal analyzer to normalize the sample signal relative to the reference signal by mathematically operating on the sample signal with the reference signal to generate a normalized signal, and determine a thickness of a layer being etched on the substrate or chamber wall from the normalized signal, wherein the mathematical operation performed on the sample signal compensates for both (i) a fluctuation in the reflected radiation that originates from the radiation source and (ii) background radiation from the plasma," and thus this claim and the claims depending therefrom are also patentable over Giapis et al. and Piwonka Corle because, as discussed above, the references do not teach or suggest a signal analyzer capable of compensating for background radiation.

Claim 30 is also patentable over Giapis et al. and Piwonka-Corle because the references do not teach or suggest a substrate etching apparatus comprising "one or more first fibers to transmit the reference radiation from the radiation source to the reference detector substantially without transmitting the reference radiation to the chamber, and one or more second fibers to transmit radiation from the radiation source to the chamber, the first and second fibers arranged to individually receive radiation from the same spatial area of the radiation source." Instead, Giapis et al. discloses a "light source 162 can be coupled to the wafer by one branch of a bifurcated fiber bundle 166 and photoluminescent light from the wafer can be coupled by the other branch of bundle 166 to a monochromator 163" (column 4, lines 41-45). Thus, Giapis et al. discloses a fiber bundle that couples the light source to a wafer in a chamber with one branch, and couples photoluminescent light from the wafer to a monochrometer by another branch. Giapis et al. does not teach one or more first fibers that transmit radiation from the radiation source to the reference detector substantially without

transmitting the reference radiation to the chamber, as recited in the claim. Giapis et al. also does not teach or suggest an arrangement of the branches of the bifurcated fiber bundle with respect to the radiation source.

Piwonka-Corle does not make up for the deficiencies of Giapis et al. Instead, Piwonka-Corle teaches a single fiber into which illuminating radiation from a lamp enters, as shown in Figure 12. This is not the same as first and second fibers arranged to individually receive radiation from the same spatial area of the radiation source. Arranging the first and second fibers to individually receive radiation from the same spatial area allows the same source fluctuations to be seen, as discussed on page 10, lines 14 to line 21, in the Specification of the instant application. Accordingly, claim 30 and the claims depending therefrom are patentable over Giapis et al. and Piwonka-Corle.

Claim 38 is patentable over Giapis et al. and Piwonka-Corle because the references do not teach or suggest "a signal analyzer to normalize the sample signal relative to the reference signal by mathematically operating on the sample signal to compensate for both (i) the background radiation from the plasma and (ii) a fluctuation in the reflected radiation," as recited in the claim. Instead, as the Examiner acknowledges, Giapis et al. does not teach "a signal analyzer adapted to normalize the sample signal relative to the reference signal by mathematically operating ..."

Piwonka-Corle does not make up for the deficiencies of Giapis et al. because Piwonka-Corle also does not teach or suggest the claimed signal analyzer that is capable of mathematically operating on the sample signal to compensate for both background radiation from the plasma and fluctuation in the reflected radiation. Instead, as discussed above, Piwonka-Corle discloses compensating for "lamp intensity fluctuations and air currents" (column 15, lines 17-18), but does not teach or suggest compensating for background radiation. Piwonka-Corle furthermore does not teach or suggest any means or motivation for compensating for background radiation that is from a plasma, as recited in the claim. For example, Piwonka-Corle does not teach or

suggest the desirability of compensating for background radiation that is from a plasma. Thus, Piwonka-Corle also does not teach or suggest the claimed signal analyzer, and claim 38 and the claims depending therefrom are patentable over Giapis et al. and Piwonka-Corle.

Claim 61 is patentable over Giapis et al. and Piwonka-Corle because the references do not teach or suggest "a signal analyzer adapted to normalize the sample signal to compensate for both (i) a fluctuation in the reflected radiation from the radiation source and (ii) background radiation that is not from the radiation source by: (1) before the gas energizer energizes the etchant gas, measuring the sample and reference signals, (2) after the gas energizer energizes the etchant gas but before substantial etching has occurred, measuring the sample signal, and (3) during etching, measuring the sample and reference signals," as recited in the claim. The Examiner has acknowledged that Giapis et al. does not teach "a signal analyzer adapted to normalize the sample signal relative to the reference signal by mathematically operating ...," and thus the claim is patentable over Giapis et al.

Piwonka-Corle does not make up for the deficiencies of Giapis et al. because, as discussed above, Piwonka-Corle does not teach or suggest a signal analyzer that is adapted to normalize a sample signal to compensate for background radiation. Instead, Piwonka-Corle discloses compensating for "lamp intensity fluctuations and air currents" (column 15, lines 17-18), but does not teach or suggest compensating for background radiation.

Furthermore, Piwonka-Corle does not teach or suggest a signal analyzer that is capable of compensating for the background radiation according to the means recited in the claim. Namely, Piwonka-Corle does not teach or suggest a signal analyzer that compensates by "(1) before the gas energizer energizes the etchant gas, measuring the sample and reference signals, (2) after the gas energizer energizes the etchant gas but before substantially etching has occurred, measuring the sample signal, and (3) during etching, measuring the sample and reference signals," as recited in the

claim as amended. The Applicant respectfully disagrees with the Examiner's assertion that these limitations are "requirements of intended use" that "generally will not limit the scope of the claim." These limitations teach structural differences between the claimed invention and Piwonka-Corle. For example, as stated in the paragraph starting on line 4 of page 24 of the Specification, these limitations may be part of an endpoint detection instruction set that comprises program code. As stated in this paragraph, "the normalization method ... is pre-programmed into the computer software," and "the compensation factor for determining background radiation is also written as program code." The endpoint instruction sets are part of a computer-readable program that is executed on a computer system under the direction of a chamber controller, as outlined in the paragraph starting on line 29 of page 17 of the Specification. Also, as stated in the paragraph starting on line 24 of page 13, the signal analyzer can be part of or the same as the computer system. Accordingly, as Piwonka-Corle does not teach or suggest a signal analyzer that is capable of compensating for background radiation, and also does not teach or suggest compensating according to the claimed means, claim 61 and the claims depending therefrom are patentable over Giapis et al. and Piwonka-Corle.

Giapis et al, Piwonka-Corle and Cates et al.

The Examiner rejected claims 6-10 and 23-29 under 35 U.S.C. 103(a) as being unpatentable over Giapis et al. and Piwonka-Corle, in view of U.S. Patent 5,328,517 to Cates et al. This rejection is respectfully traversed.

Claim 1, from which claims 6-10 depend, is patentable over Giapis et al, Piwonka-Corle and Cates et al, because the references do not teach or suggest "a signal analyzer to normalize the sample signal relative to the reference signal by mathematically operating on the sample signal to compensate for both (i) a fluctuation in the reflected radiation that originates from the radiation source and (ii) background radiation from the plasma," as recited in the claim. Giapis et al. and Piwonka-Corle have been discussed above, and do not teach or suggest the recited signal analyzer.

Cates et al. does not make up for the deficiencies of Giapis et al. and Piwonka-Corle. Cates et al. discloses that a processor may divide a signal from a detector, e.g. a photodiode array, by "a corresponding normalization signal obtained from a sample optical energy (18') of the light from [the optical energy] source (14)." (Col. 15, lines 61-65.) The outputs of detectors are normalized "for variations in the intensity of the output of optical energy source." (Col. 17, line 64 to col. 18, line 2.) However, normalizing for variations in the intensity of the output of the optical energy source is not the same as compensating for background radiation that is from a plasma. Accordingly, Cates et al. does not teach or suggest the claimed signal analyzer, and claim 1 and the claims depending therefrom are patentable over Giapis et al, Piwonka-Corle and Cates et al.

Claim 23 is patentable over Giapis et al, Piwonka-Corle and Cates et al. because the references do not teach or suggest "a signal analyzer to normalize the sample signal relative to the reference signal by mathematically operating on the sample signal to compensate for both (i) fluctuation in the reflected light that originates from the light source, and (ii) background light from the plasma, by receiving the sample signal and the reference signal and determining a corrected sample signal, X_{nt}, using the expression $X_{nt} = X_t / \{Y_0 + C(Y_t - Y_0)\}$, where C is a correction factor that corrects for the background light, Y_0 is the reference signal at time 0, X_t is the sample signal at time t, and Y_t is the reference signal at time," as recited in the claims. The Examiner acknowledges that Giapis et al. and Piwonka Corle "do not teach a signal analyzer that performs the normalization by assigning a specific mathematical algorithm for the normalization." Accordingly, claim 23 is patentable over Giapis et al. and Piwonka-Corle.

Cates et al. does not make up for the deficiencies of Giapis et al. and Piwonka-Corle because Cates et al. also does not teach or suggest the recited signal analyzer that is capable of determining a corrected sample signal according to the recited mathematical operation. Instead, Cates et al. discloses a processor which

generates a signal that is a weighted sum average (column 18, lines 24-44.) A processor that uses this mathematical form is different from a signal analyzer that uses the mathematical expression $X_{nt} = X_t / \{Y_0 + C(Y_t - Y_0)\}$ to determine a normalized sample signal that is compensated for source fluctuations and background radiation, as in the claim. Cates et al. also does not teach or suggest the desirability of the correction factor C, which is important to provide compensation for background radiation as described for example on pages 15 and 16 of the Specification. Cates et al. does not teach or suggest the use of this correction factor C, or the specific formulation of the above mathematical expression that is used by the signal analyzer. Accordingly, Cates et al. does not teach or suggest the claimed signal analyzer, and claim 23 and the claims depending therefrom are patentable over Giapis et al, Piwonka-Corle and Cates et al.

Giapis et al, Piwonka-Corle and Taketora

The Examiner rejected claim 36 under 35 U.S.C. 103(a) as being unpatentable over Giapis et al. and Piwonka Corle, in view of Japanese Patent JP01260304 to Taketora. This rejection is respectfully traversed.

Claim 30, from which claim 36 depends, is patentable over Giapis et al, Piwonka-Corle and Taketora because the references do not teach or suggest "one or more first fibers to transmit the reference radiation from the radiation source to the reference detector substantially without transmitting the reference radiation to the chamber, and one or more second fibers to transmit radiation from the radiation source to the chamber, the first and second fibers arranged to individually receive radiation from the same spatial area of the radiation source," as recited in the claim. Giapis et al. and Piwonka-Corle have been discussed above, and do not teach or suggest the recited one or more first fibers that transmit radiation from the radiation source to the reference detector substantially without transmitting the reference radiation to the chamber. Furthermore, as was also discussed above, Giapis et al. and Piwonka-Corle also do not teach or suggest the signal analyzer that is capable of mathematically

operating on a sample signal to compensate for background radiation from a plasma. Thus claim 30 and the claims depending therefrom are patentable over Giapis et al. and Piwonka-Corle.

Taketora does not make up for the deficiencies of Giapis et al. and Piwonka-Corle. Taketora is silent on the matter of fibers that transmit radiation, and thus Taketora does not teach or suggest the recited one or more first fibers that transmit reference radiation to the reference detector substantially without transmitting to the chamber. Taketora also does not teach or suggest the recited signal analyzer. Accordingly, claim 30 and the claims depending therefrom are patentable over Giapis et al, Piwonka-Corle and Taketora.

Giapis et al, Ish-Shalom et al. and Moslehi

The Examiner rejected claims 40-51 and 57-59 under 35 U.S.C. 103(a) as being anticipated by Giapis et al. in view of U.S. Patent 6,299,346 to Ish-Shalom et al. and US Patent 5,156,461 to Moslehi. This rejection is respectfully traversed.

Claim 40 is patentable over Giapis et al. in view of Ish-Shalom et al. and Moslehi because the references do not teach or suggest "a feedback controller to regulate a power level of the radiation source in relation to the detected intensity of the second radiation," as recited in the claim. The Examiner acknowledges that "Giapis [et al.] does not teach a feedback controller adapted to regulate a power level of the radiation source in relation to the detected intensity of the second radiation." Accordingly, claim 40 is patentable over Giapis et al.

The Examiner furthermore acknowledges that "Ish-Shalom does not teach a controller (36) having feedback capacity adapted to regulate a power level of the reference radiation." Furthermore, Ish-Shalom et al. does not teach or suggest a feedback controller that regulates a power level of the radiation source in relation to the detected intensity of the second radiation. Instead, Ish-Shalom et al. teaches a control

system that "provides incident radiation (40) intermittently by turning radiation source (28) on and off" (column 11, lines 9-10.) This is different from the feedback controller of claim 40 because the control system does not regulate the radiation source power level "in relation to" a detected intensity of a second radiation or a reference signal. The "control system" turns the radiation source on and off at a predefined constant rate, whereas the recited "feedback controller" regulates the power level variably "in relation to the intensity" measured in real-time. Accordingly, Ish-Shalom et al. also does not teach or suggest the feedback controller recited in the claim, and claim 40 and the claims depending therefrom are patentable over Giapis et al. and Ish-Shalom et al.

Moslehi does not make up for the deficiencies of Giapis et al. and Ish-Shalom et al. In the section to which the Examiner refers, Moslehi discloses that "to control the input power of tungsten-halogen heating lamp module 134, process control computer 126 sends power control signals via line 138 to PID controller 136 in response to temperature sensor outputs (received via line 140.) Sensing lines 140 to process control computer 126 from tungsten-halogen heating lamp module include signals from multi-point temperature sensor of the present invention which measure the temperature of the semiconductor wafer 22 in real time" (column 6, lines 57-65.) Thus, Moslehi discloses controlling the input power of tungsten-halogen heating lamp module in relation to a measured temperature of a semiconductor wafer. Moslehi does not teach or suggest a feedback controller to control a property of radiation in relation to the detected intensity of a second radiation, the second radiation being from the radiation source. Accordingly, Moselehi does not teach or suggest the recited feedback controller, and claim 40 and the claims depending therefrom are patentable over Giapis et al, Ish-Shalom et al. and Moslehi.

Claim 44 is patentable over Giapis et al, Ish-Shalom et al. and Moslehi because the references do not teach or suggest "a radiation modulator in a path of a radiation being transmitted from the radiation source to the chamber, the radiation modulator being adapted to receive the reference signal and control a property of the radiation in relation to the reference signal," as recited in the claim. Giapis et al. is silent

on the matter of a radiation modulator adapted to control a property of the radiation in relation to the reference signal.

Ish-Shalom et al. does not make up for the deficiencies of Giapis et al. because Ish-Shalom et al. also does not teach or suggest the recited radiation modulator that is adapted to receive the reference signal and control a property of the radiation in relation to the reference signal. Instead, Ish-Shalom et al. teaches a shutter (23) to alternately allow incident radiation (40) from reaching a wafer (10) and block the incident radiation from reaching the wafer. However, the shutter does not alternately allow/block the radiation "in relation to" a reference signal that corresponds to a property of radiation detected from the radiation source. Instead, Ish-Shalom et al. alternately blocks of the radiation irrespective of any particular reference signal. Thus, the shutter of Ish-Shalom et al. is not a radiation modulator adapted to control a property of the radiation in relation to the reference signal as recited in claim 44. Furthermore, Ish-Shalom et al. does not teach, suggest or provide motivation for the shutter receiving a reference signal that relates to a detected property of radiation from the radiation source.

Moslehi also does not make up for the deficiencies of Giapis et al. and Ish-Shalom et al. Moslehi discloses that "to control the input power of tungsten-halogen heating lamp module 134, process control computer 126 sends power control signals via line 138 to PID controller 136 in response to temperature sensor outputs (received via line 140.) Sensing lines 140 to process control computer 126 from tungsten-halogen heating lamp module include signals from multi-point temperature sensor of the present invention which measure the temperature of the semiconductor wafer 22 in real time" (column 6, lines 57-65.) Thus, Moslehi discloses controlling the input power of tungsten-halogen heating lamp module in relation to a measured temperature of a semiconductor wafer. Moslehi does not teach or suggest a feedback controller to regulate a power level of the radiation source in relation to a reference signal that is generated in relation to a detected property of radiation of the radiation source. Accordingly, claim 44 and the claims depending therefrom are patentable over Giapis et

al, Ish-Shalom et al. and Moslehi.

Claim 57 is patentable over Giapis et al, Ish-Shalom et al. and Moslehi because the references do not teach or suggest "a feedback controller to regulate a power level of the radiation source in relation to the reference signal," as recited in the claim, where the reference signal is in relation to a property of radiation from the radiation source. As acknowledged by the Examiner, "Giapis [et al.] does not teach a feedback controller adapted to regulate a power level of the radiation source in relation to the detected intensity of the second radiation." Accordingly, claim 57 and the claims depending therefrom are not patentable over Giapis et al.

Ish-Shalom et al. does not make up for the deficiencies of Giapis et al. As discussed above, the Examiner has acknowledged that "Ish-Shalom does not teach a controller (36) having feedback capacity adapted to regulate a power level of the reference radiation." Furthermore, Ish-Shalom et al. does not teach or suggest a feedback controller that regulates a power level of the radiation source in relation to a reference signal that is generated in relation to a property of radiation from the radiation source. Instead, Ish-Shalom et al. teaches a control system that "provides incident radiation (40) intermittently by turning radiation source (28) on and off" (column 11, lines 9-10.) This is different from the feedback controller of claim 57 because the control system does not regulate the radiation source power level "in relation to" a detected intensity of a second radiation or a reference signal. The "control system" turns the radiation source on and off at a predefined constant rate, whereas the recited "feedback controller" regulates the power level variably "in relation to the intensity" measured in real-time. Accordingly, Ish-Shalom et al. also does not teach or suggest the feedback controller recited in the claim, and claim 57 and the claims depending therefrom are patentable over Giapis et al. and Ish-Shalom et al.

Moslehi does not make up for the deficiencies of Giapis et al. and Ish-Shalom et al. In the section to which the Examiner refers, Moslehi discloses that "to control the input power of tungsten-halogen heating lamp module 134, process control

computer 126 sends power control signals via line 138 to PID controller 136 in response to temperature sensor outputs (received via line 140.) Sensing lines 140 to process control computer 126 from tungsten-halogen heating lamp module include signals from multi-point temperature sensor of the present invention which measure the temperature of the semiconductor wafer 22 in real time" (column 6, lines 57-65.) Thus, Moslehi discloses controlling the input power of tungsten-halogen heating lamp module in relation to a measured temperature of a semiconductor wafer. Moslehi does not teach or suggest a feedback controller to control a property of radiation in relation to a reference signal that is related to a property of radiation of the radiation source. Accordingly, Moselehi does not teach or suggest the recited feedback controller, and claim 57 and the claims depending therefrom are patentable over Giapis et al, Ish-Shalom et al. and Moslehi.

Giapis et al, Ish-Shalom, Moslehi and Piwonka-Corle

The Examiner rejected claim 60 under 35 U.S.C. 103(a) as being anticipated by Giapis et al., Ish-Shalom et al. and Moslehi in view of Piwonka-Corle. This rejection is respectfully traversed.

Claim 40, from which claim 60 depends, is patentable over Giapis et al, Ish-Shalom et al, Moslehi and Piwonka-Corle because the references do not teach or suggest "a feedback controller to regulate a power level of the radiation source in relation to the detected intensity of the second radiation," as recited in the claim. Giapis et al, Ish-Shalom et al. and Moslehi et al. have been discussed above, and do not teach or suggest the recited feedback controller. Piwonka-Corle furthermore does not make up for the deficiencies of these references because Piwonka-Corle also does not teach or suggest using a feedback controller to regulate the power level of the radiation source based the intensity of a radiation detected from the radiation source. Accordingly, claim 40 and the claims depending therefrom are patentable over Giapis et al, Ish-Shalom et al, Moslehi and Piwonka-Corle.

CONCLUSION

The above-discussed amendments are believed to place the present application in condition for allowance. Should the Examiner have any questions regarding the above remarks, the Examiner is requested to telephone Applicant's representative at the number listed below.

Respectfully submitted,

JANAH & ASSOCIATES, P.C.

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